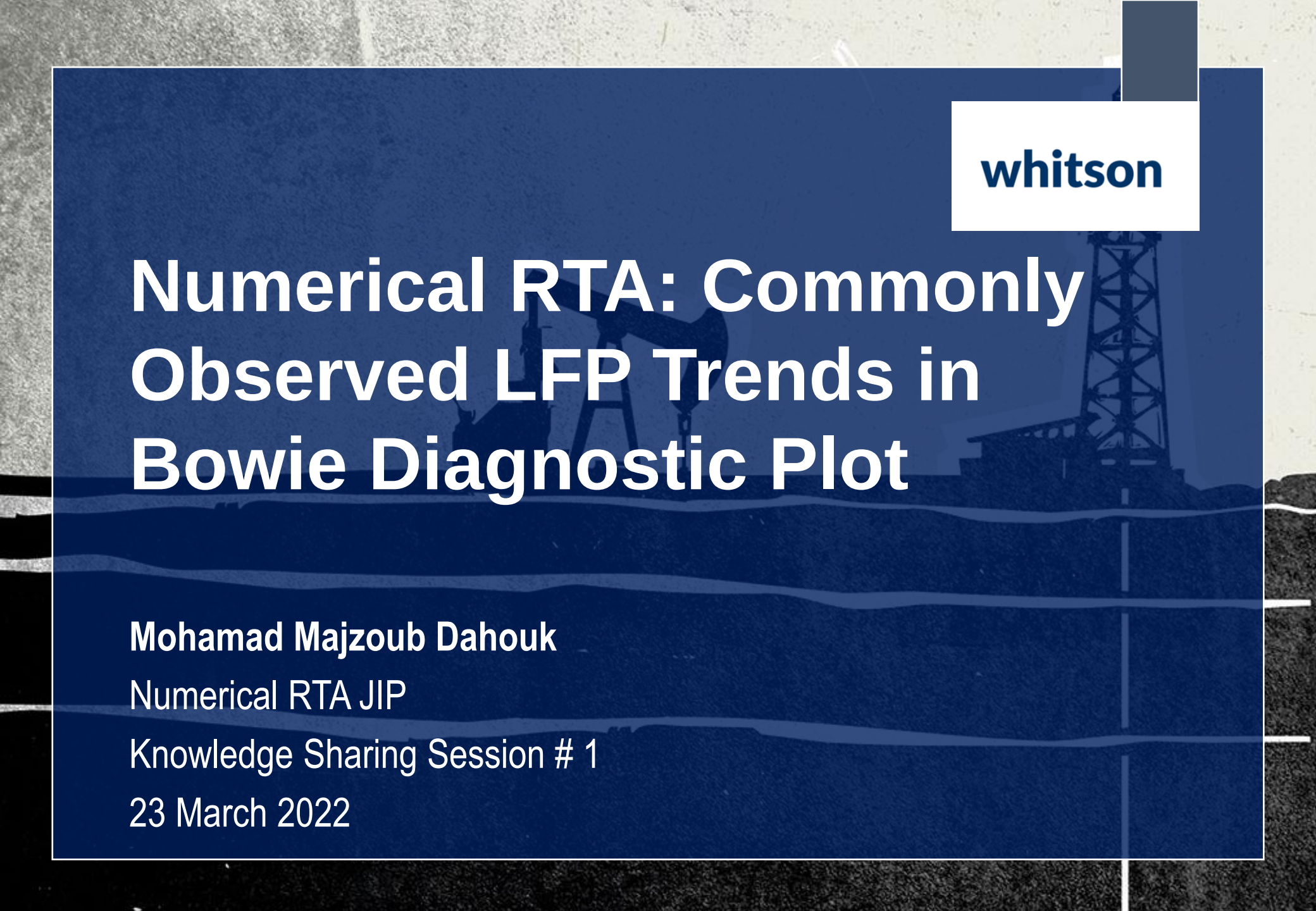


whitson

Numerical RTA: Commonly Observed LFP Trends in Bowie Diagnostic Plot

Mohamad Majzoub Dahouk

Numerical RTA JIP

Knowledge Sharing Session # 1

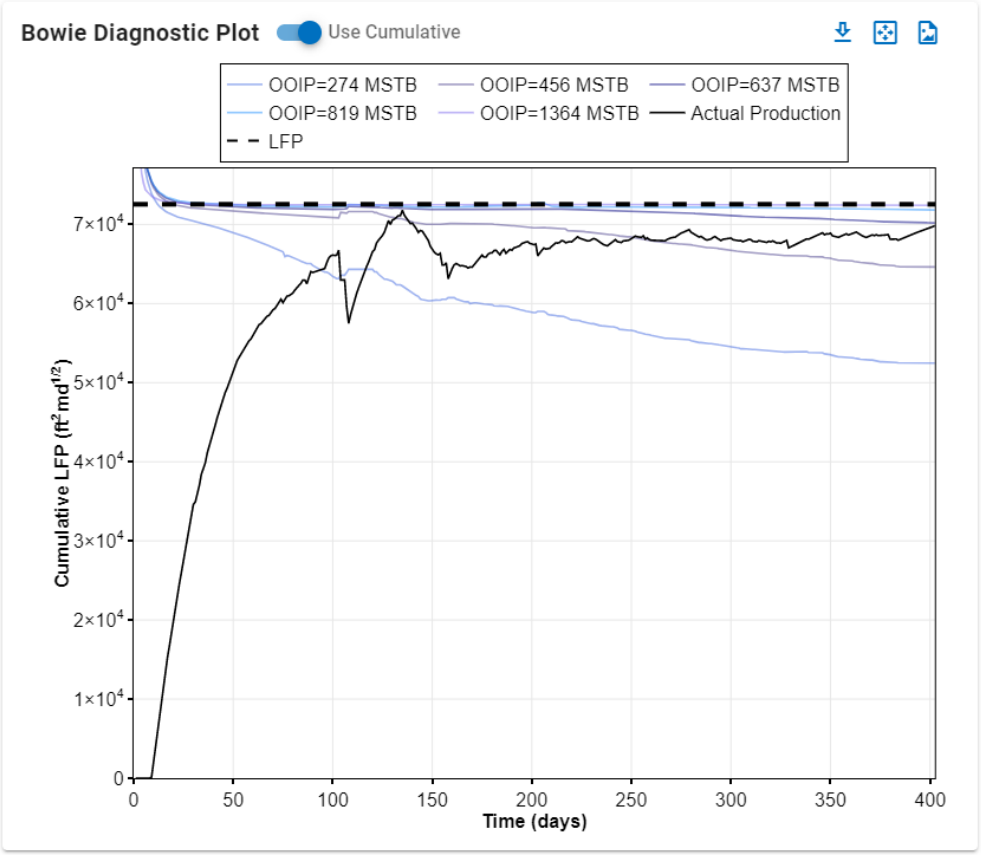
23 March 2022

Why are we here? To talk Bowie & LFPs

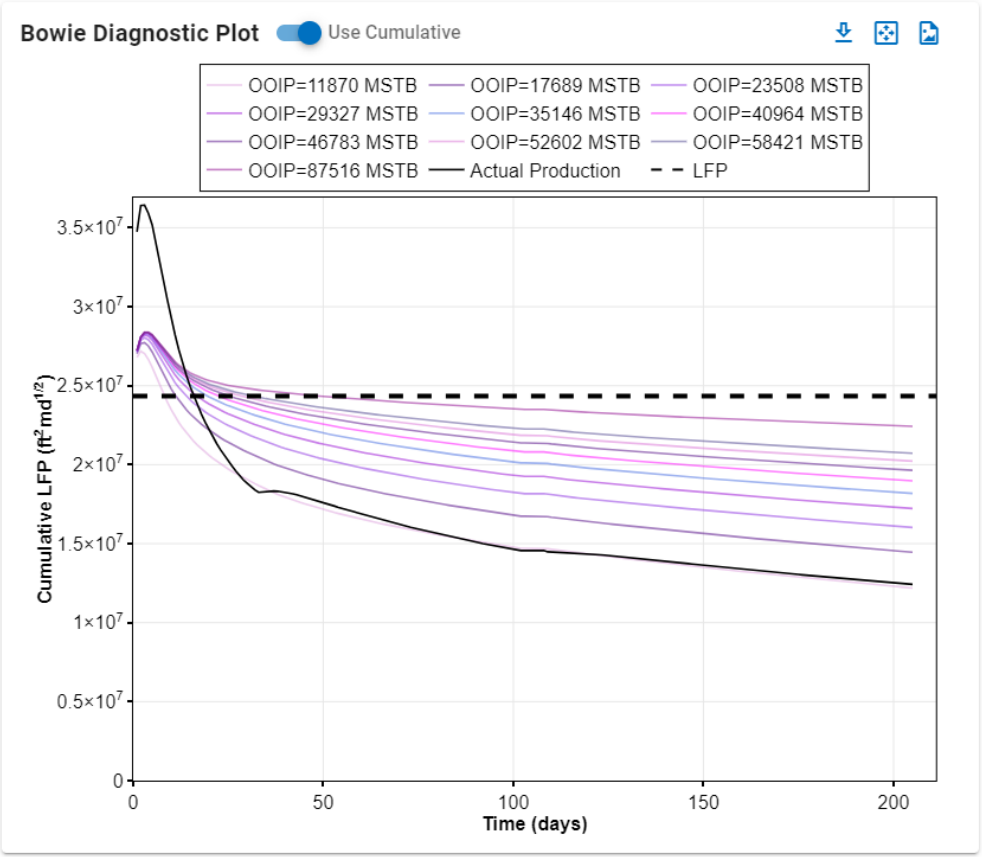
$$LFP = LFP = 4n_f x_f h\sqrt{k}$$

whitson

Why are we here? To talk Bowie & LFP



90%

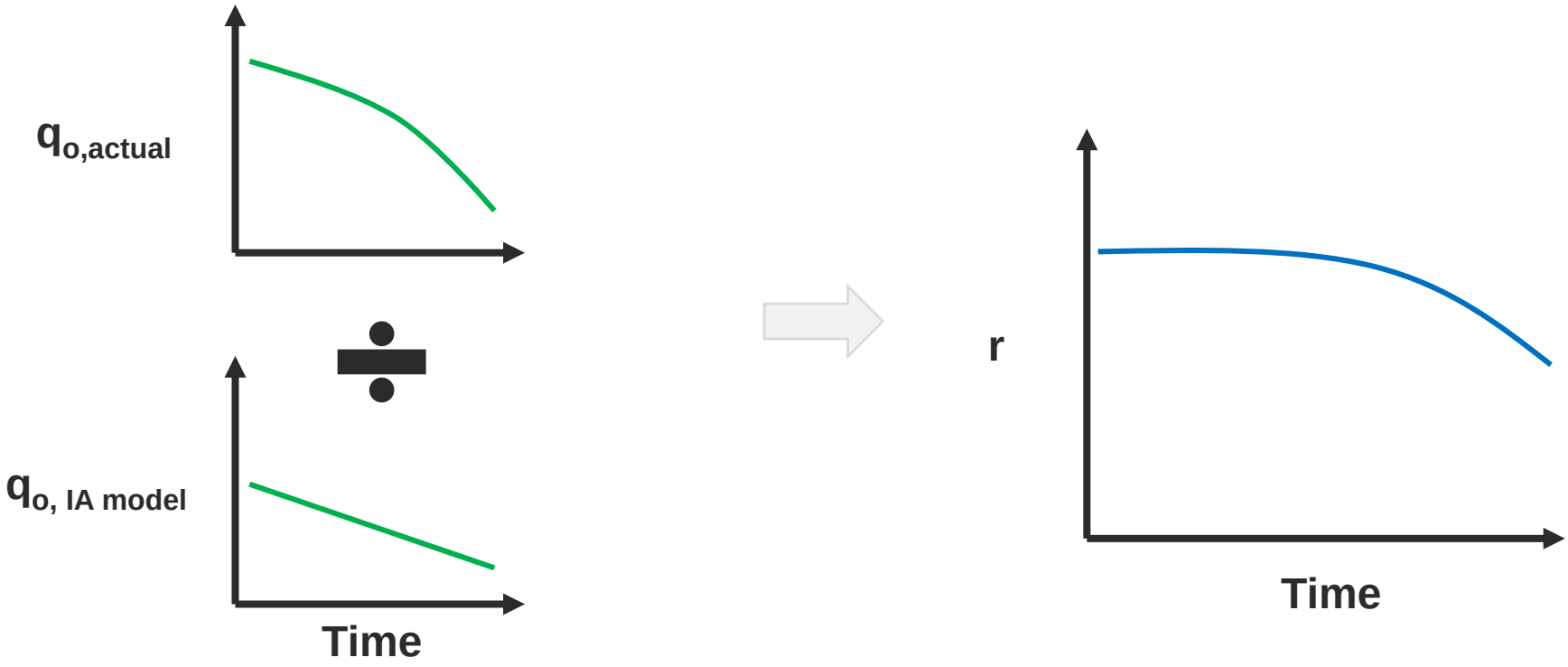


10%

whitson

Theory Reminder: “Bowie Workflow”

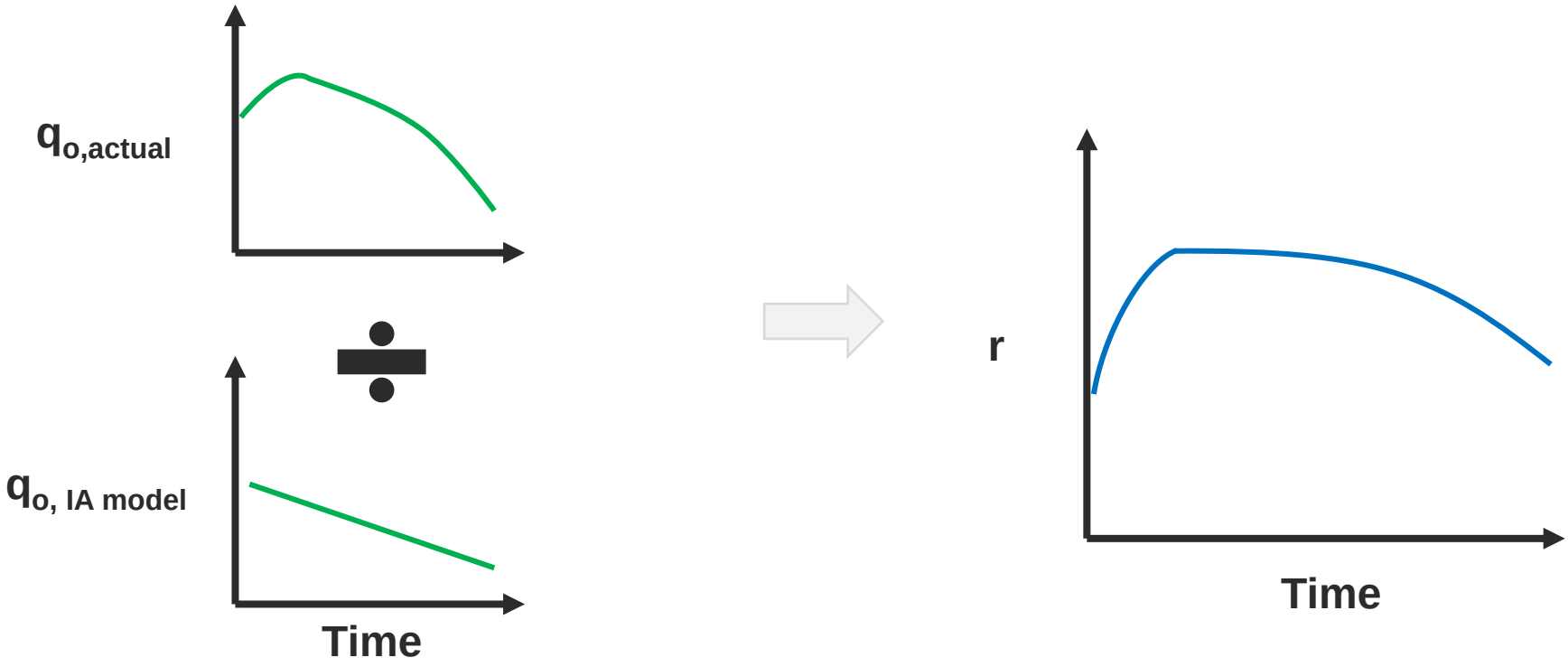
Step 3. Calculate the ratio between the actual measured oil rates and infinite acting model oil rates: $r = q_{o,actual}/q_{o,IA}$



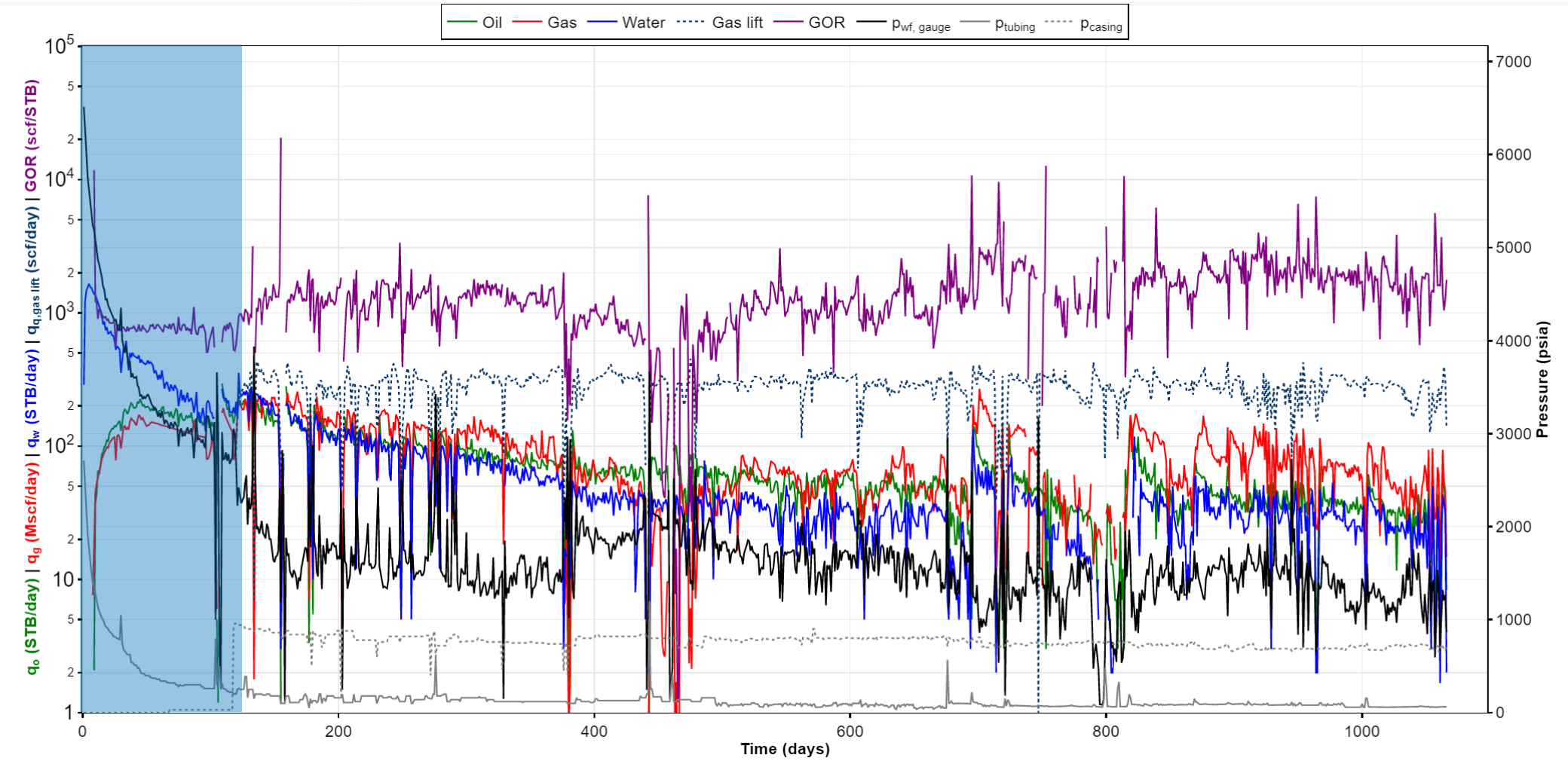
whitson

Reality Reminder: "Bowie Workflow"

Step 3. Calculate the ratio between the actual measured oil rates and infinite acting model oil rates: $r = q_{o,actual}/q_{o,IA}$

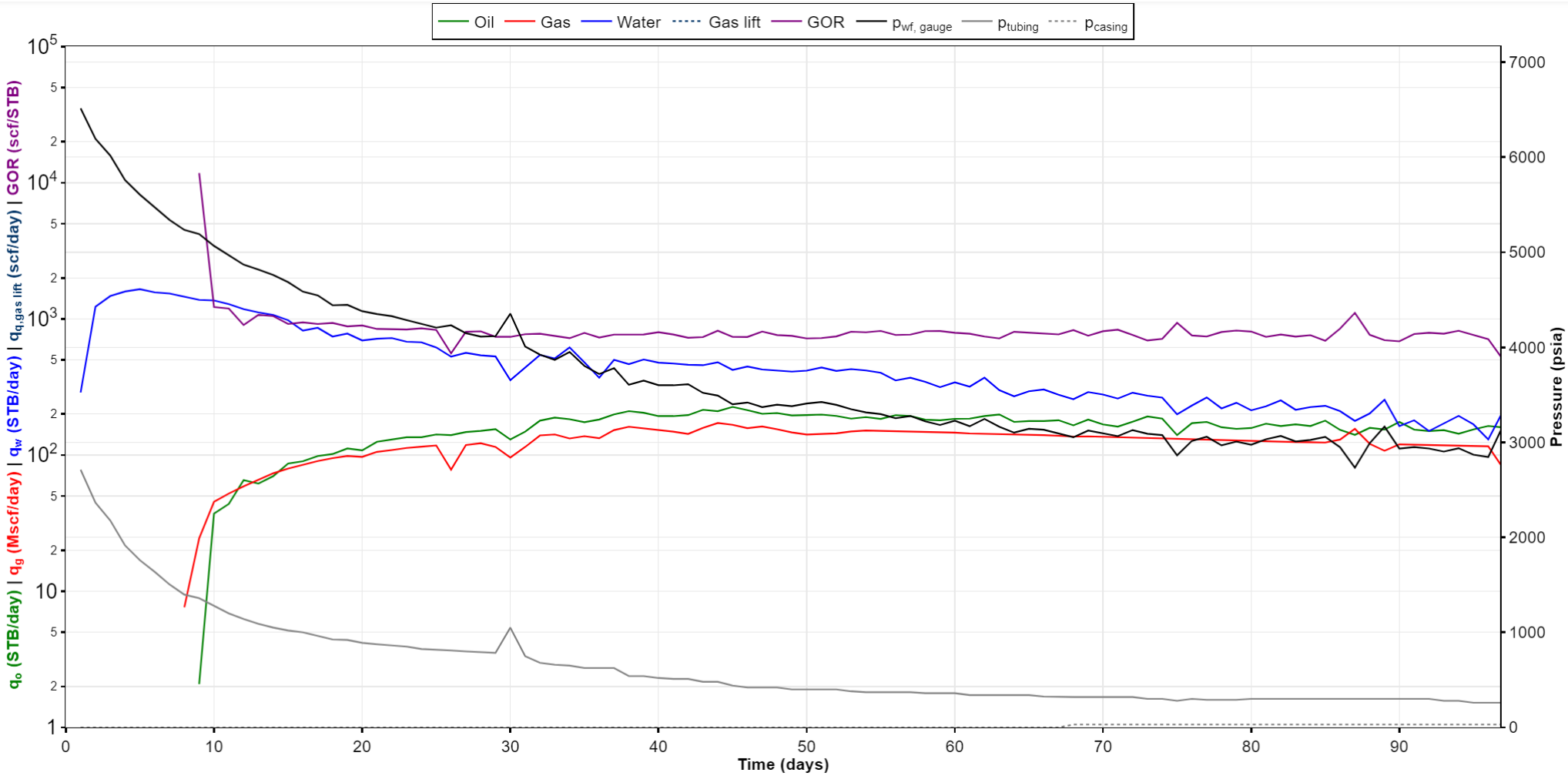


SPE Data Repository Well # 4



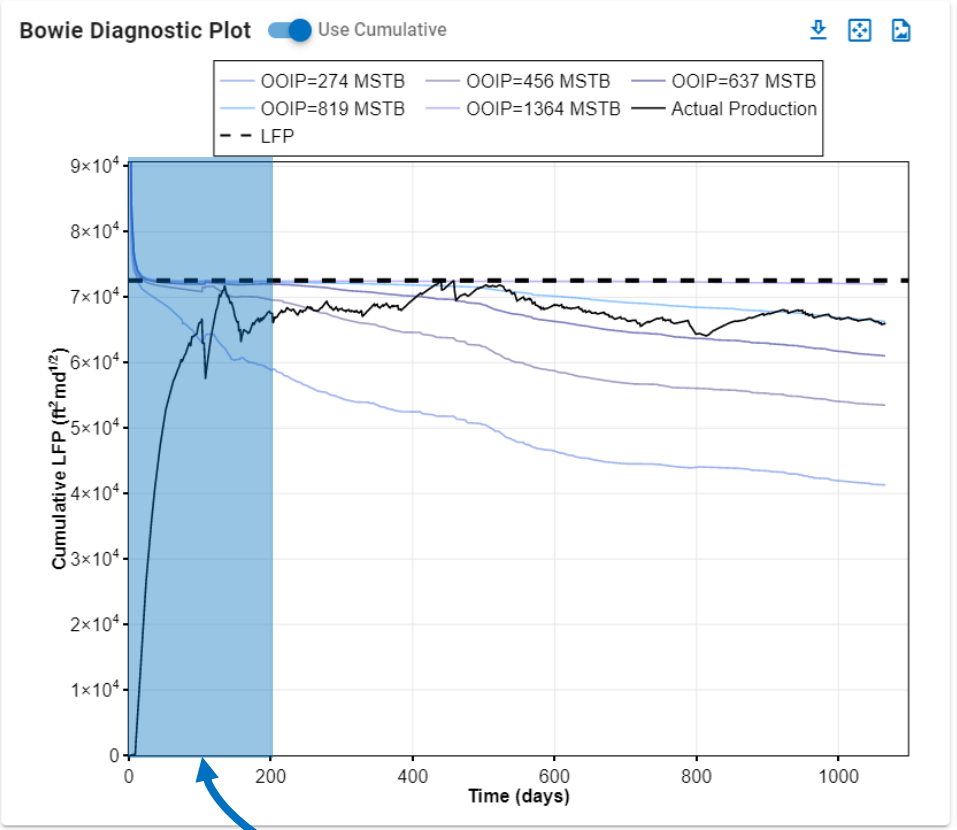
whitson

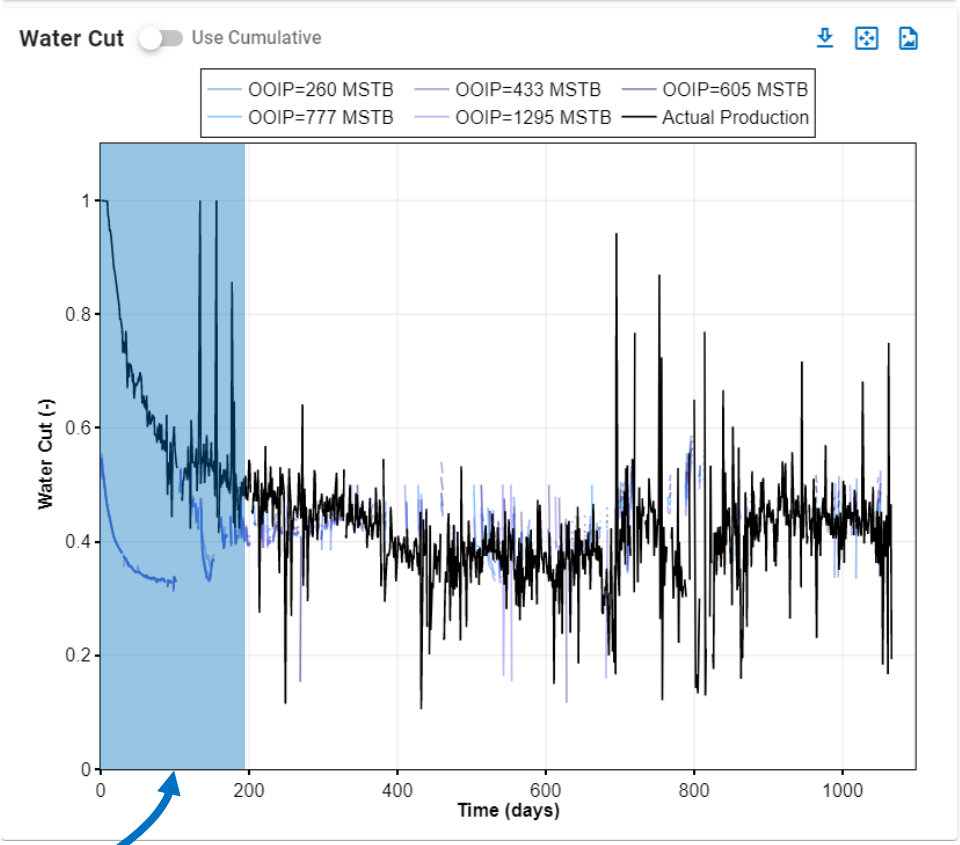
SPE Data Repository Well # 4



whitson

SPE Data Repository Well # 4

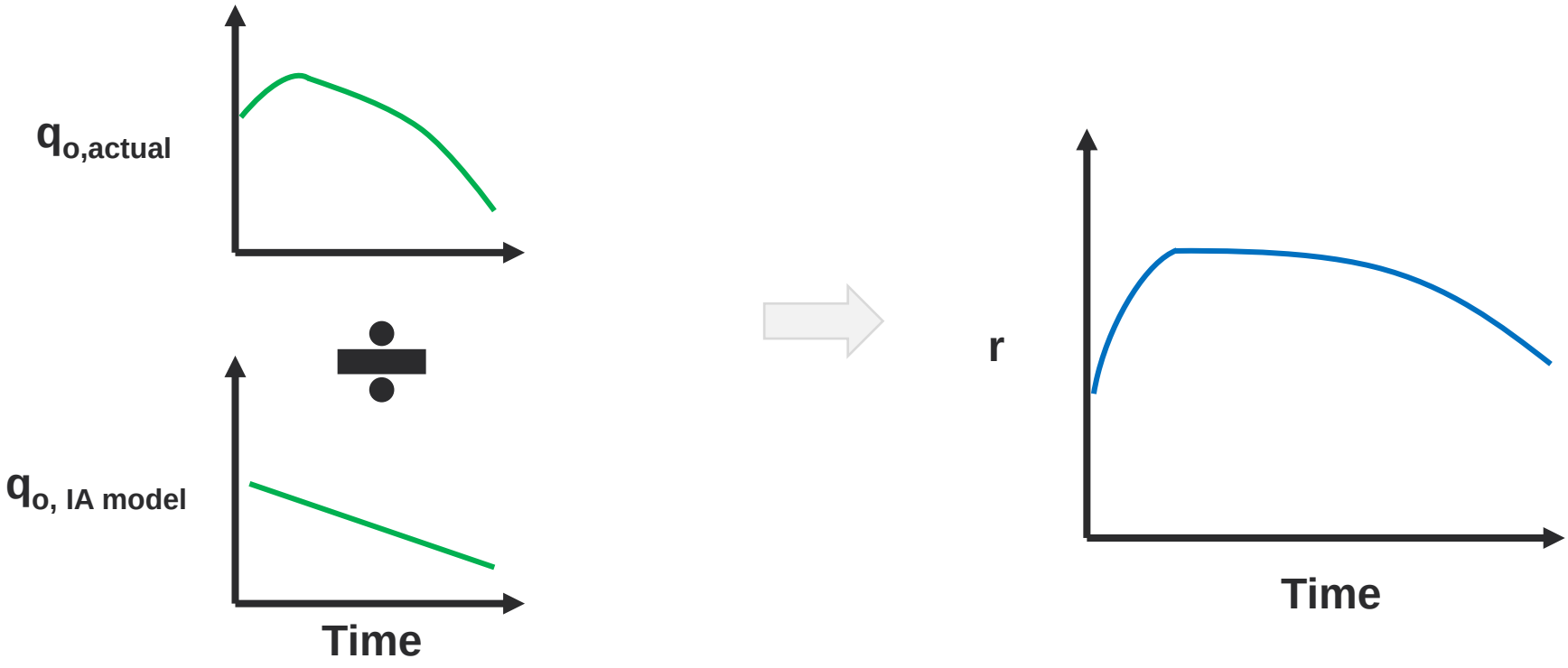




whitson

What else can affect the LFP plot?

Anything that would make $q_{model} > q_{actual}$



We will study two important ones:

- Initial reservoir pressure
- Dimensionless fracture conductivity (Fcd)

Effect of Initial Reservoir Pressure

Synthetic Well

Well & Reservoir Data

h:	200 ft	k_m:	200 nd
h_f:	200 ft	φ_m:	0.05
x_e:	400 ft	F_{cd}:	1000
x_f:	400 ft	k_{EFR}:	-
L_w:	6000 ft	y_{EFR}:	-
N_f:	40	y_e:	75 ft

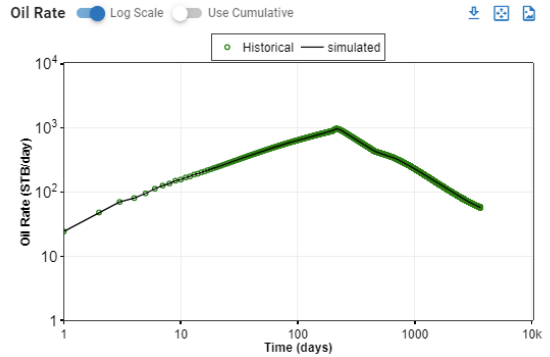
Fluid Initialization

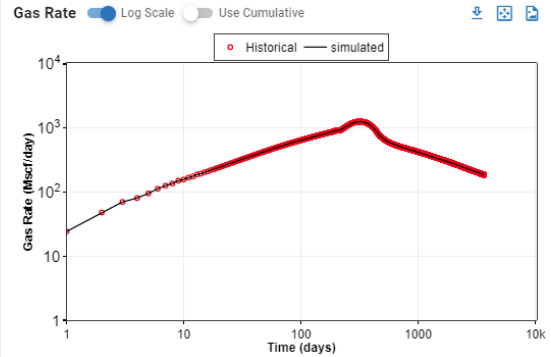
GOR_i:	1000 scf/STB
S_{wi}:	30 %
T_R:	250 F
p_{bi}:	8000 psia

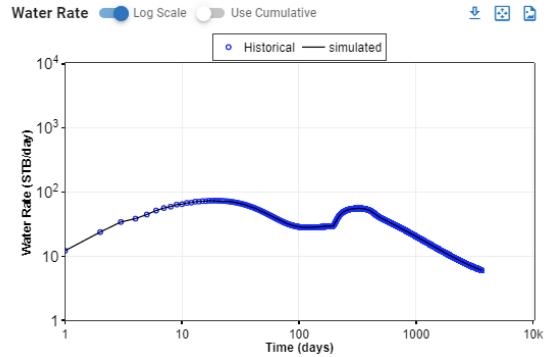
Matrix Relative Permeability

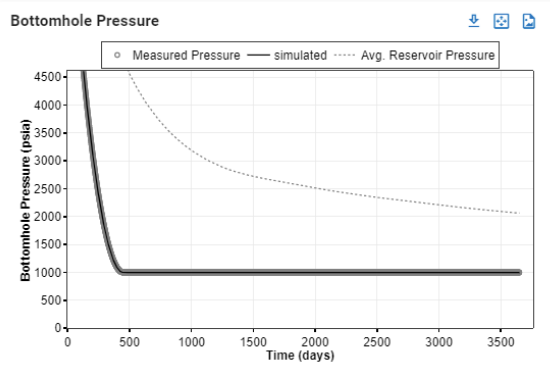
S_{wc}:	20.00 %	S_{orw}:	20.00 %
S_{org}:	20.00 %	S_{gc}:	5.00 %
n_w:	2	n_{ow}:	2
n_g:	2	n_{og}:	2
k_{rwro}:	1	k_{rocw}:	1
k_{rgro}:	1		

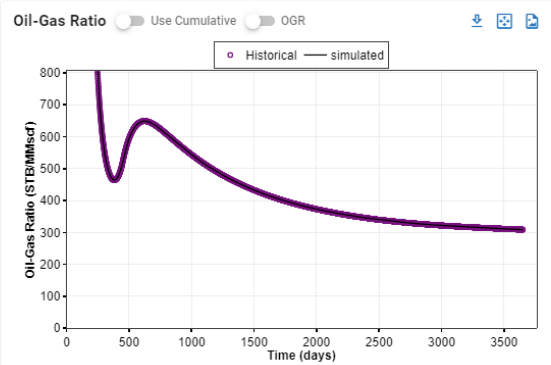
Original Oil in Place		Original Gas in Place		Original Water in Place	
4014	MSTB	4013.9	MMscf	2630.4	MSTB

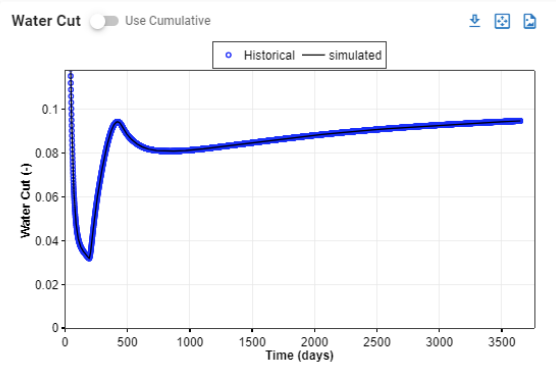






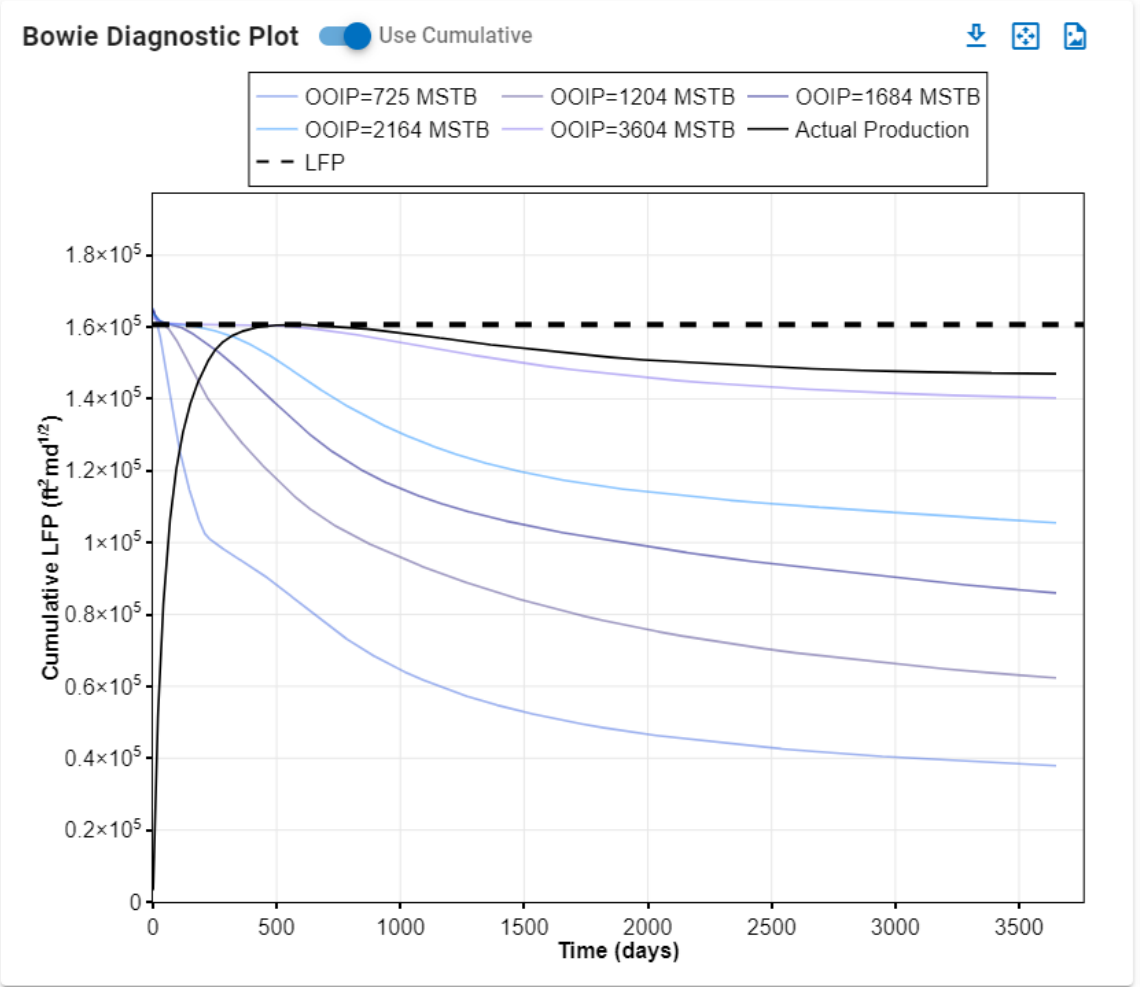






whitson

Higher Reservoir Pressure



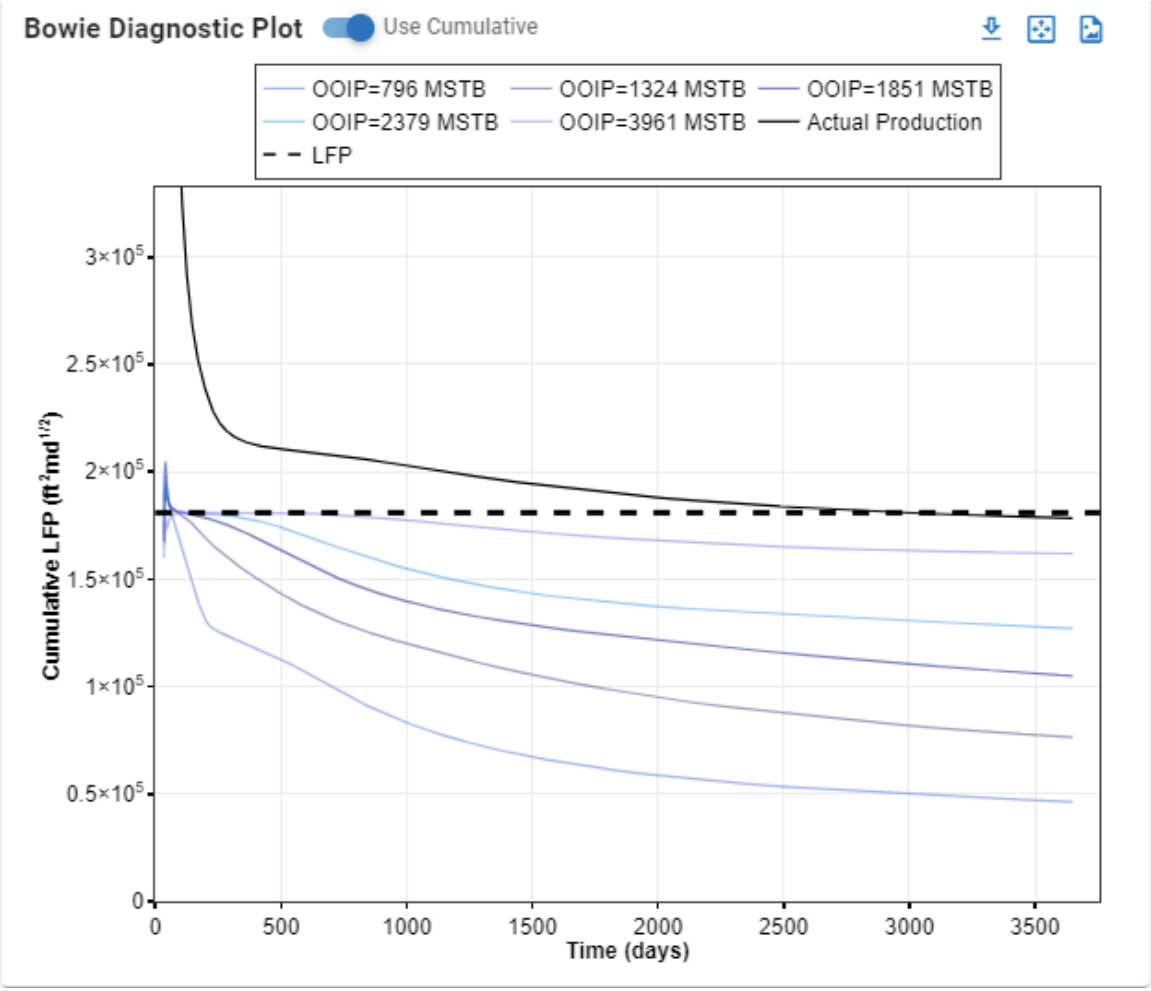
Actual Pi = 8000 psia

Pi in NRTA = 9000 psia

Model Production > Actual Production

whitson

Lower Reservoir Pressure



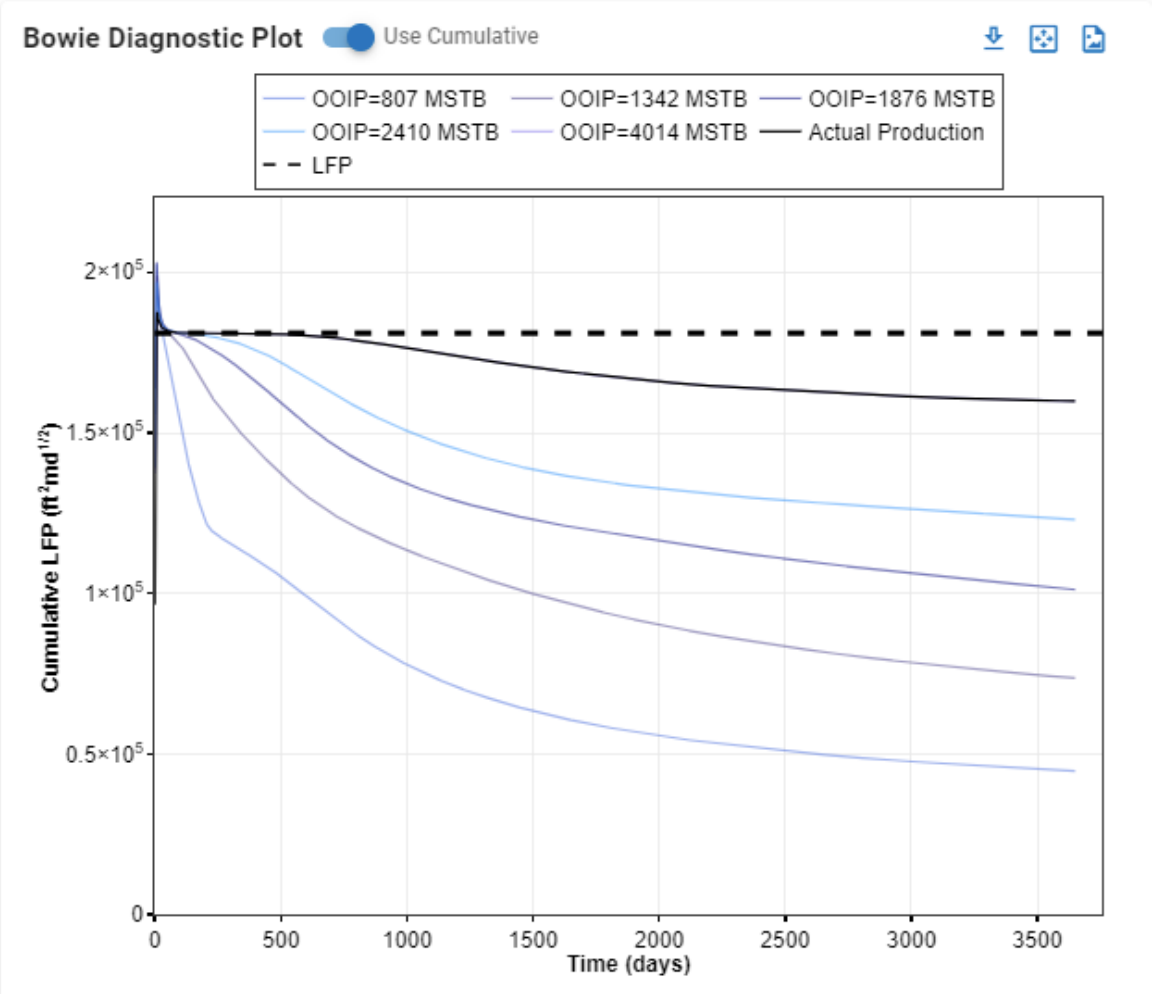
Actual Pi = 8000 psia

Pi in NRTA = 7000 psia

Model Production < Actual Production

whitson

Correct Reservoir Pressure



Actual Pi = 8000 psia

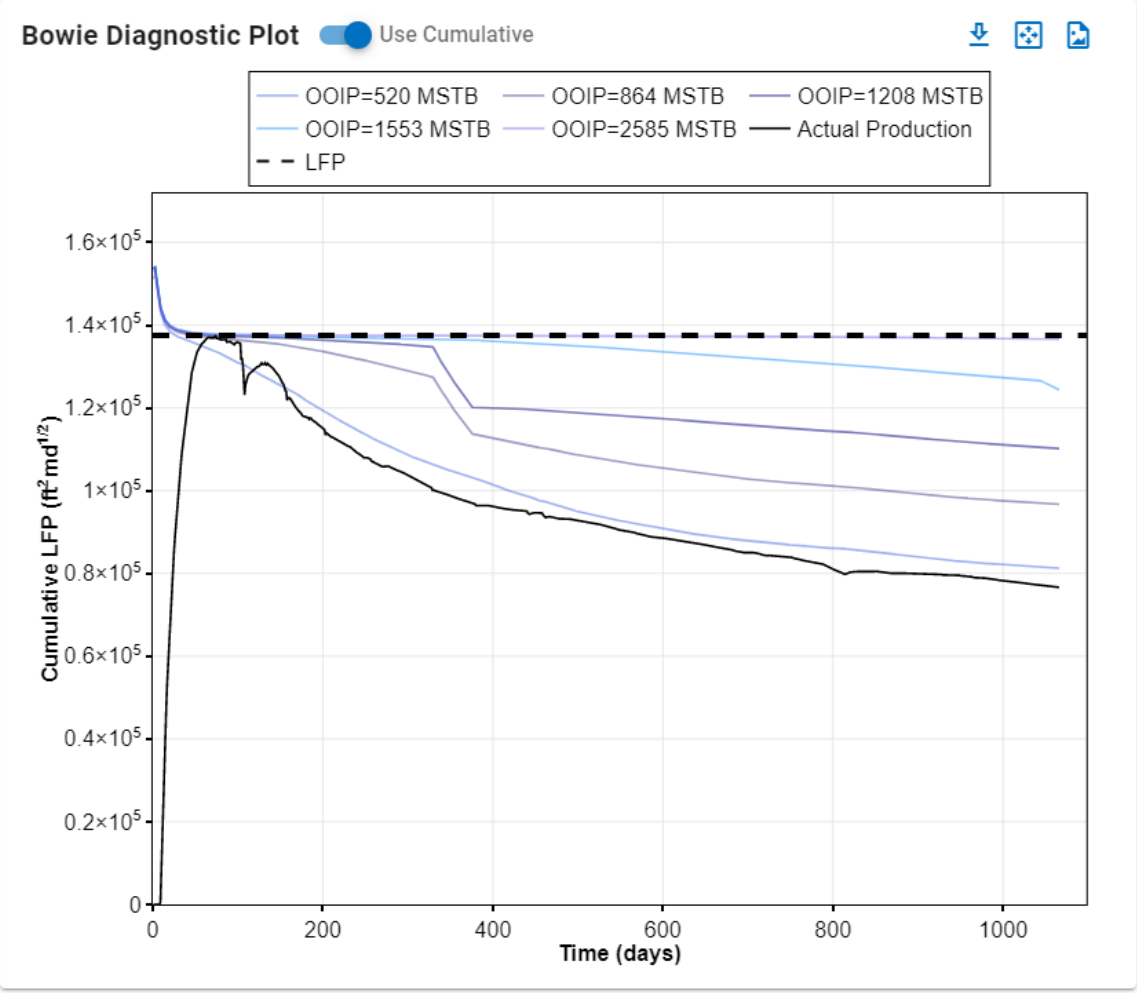
Pi in NRTA = 8000 psia

Model Production = Actual Production

whitson

Effect of Fcd

SPE Data Repository Well # 4

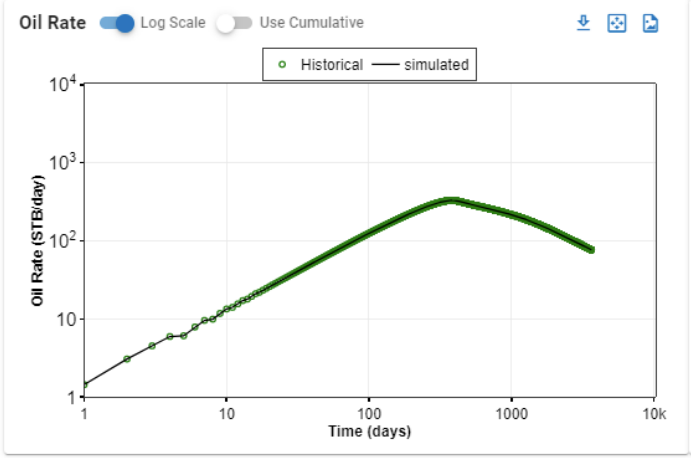


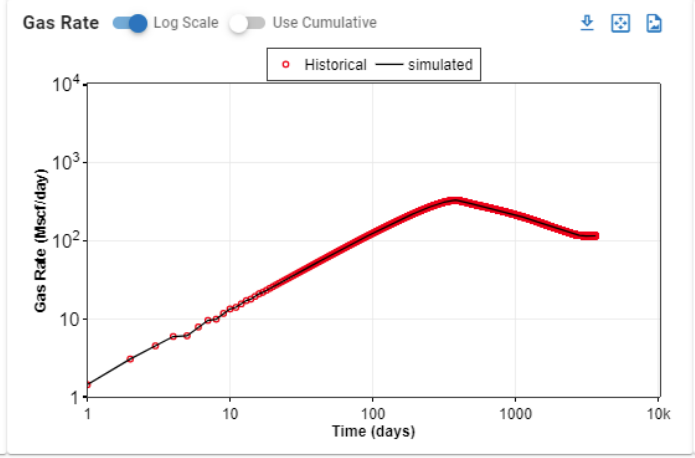
Lowering Fcd makes the "shooting up" period shorter, but in this case results in a very poor match of the rest of the data

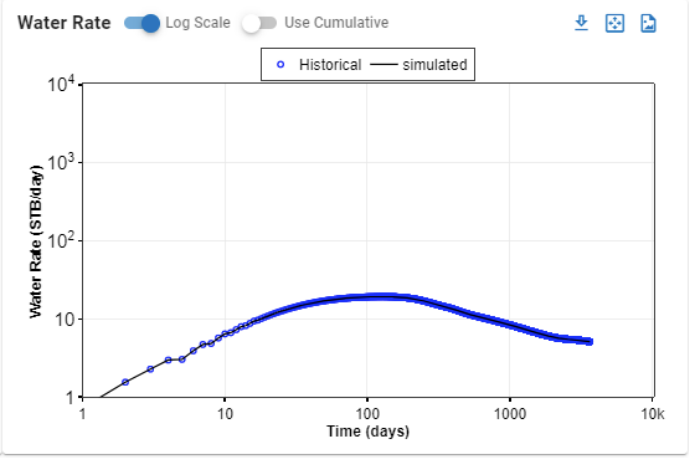
whitson

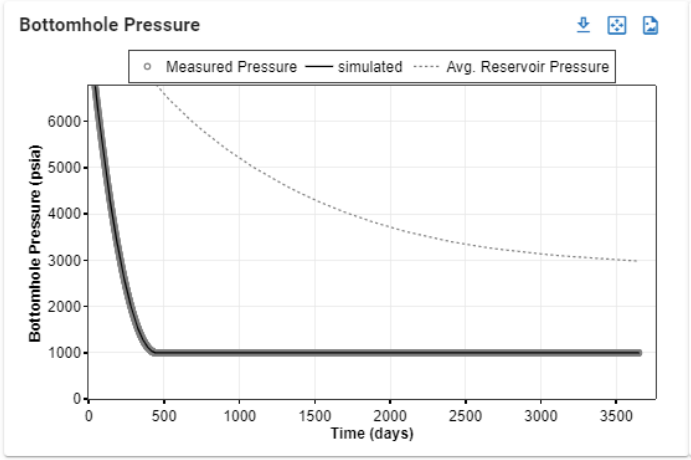
Synthetic Low Fcd Well | Fcd = 5

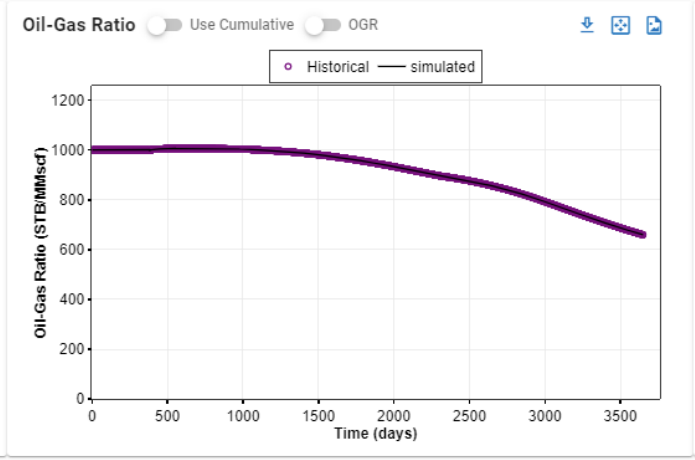
Original Oil in Place		Original Gas in Place		Original Water in Place	
4014	MSTB	4013.9	MMscf	2630.4	MSTB

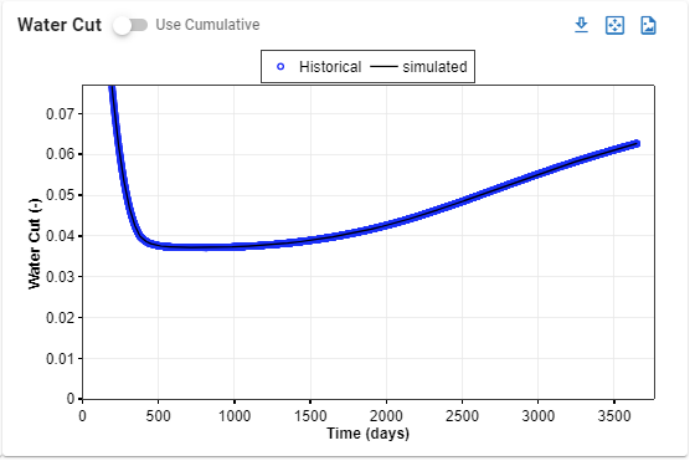






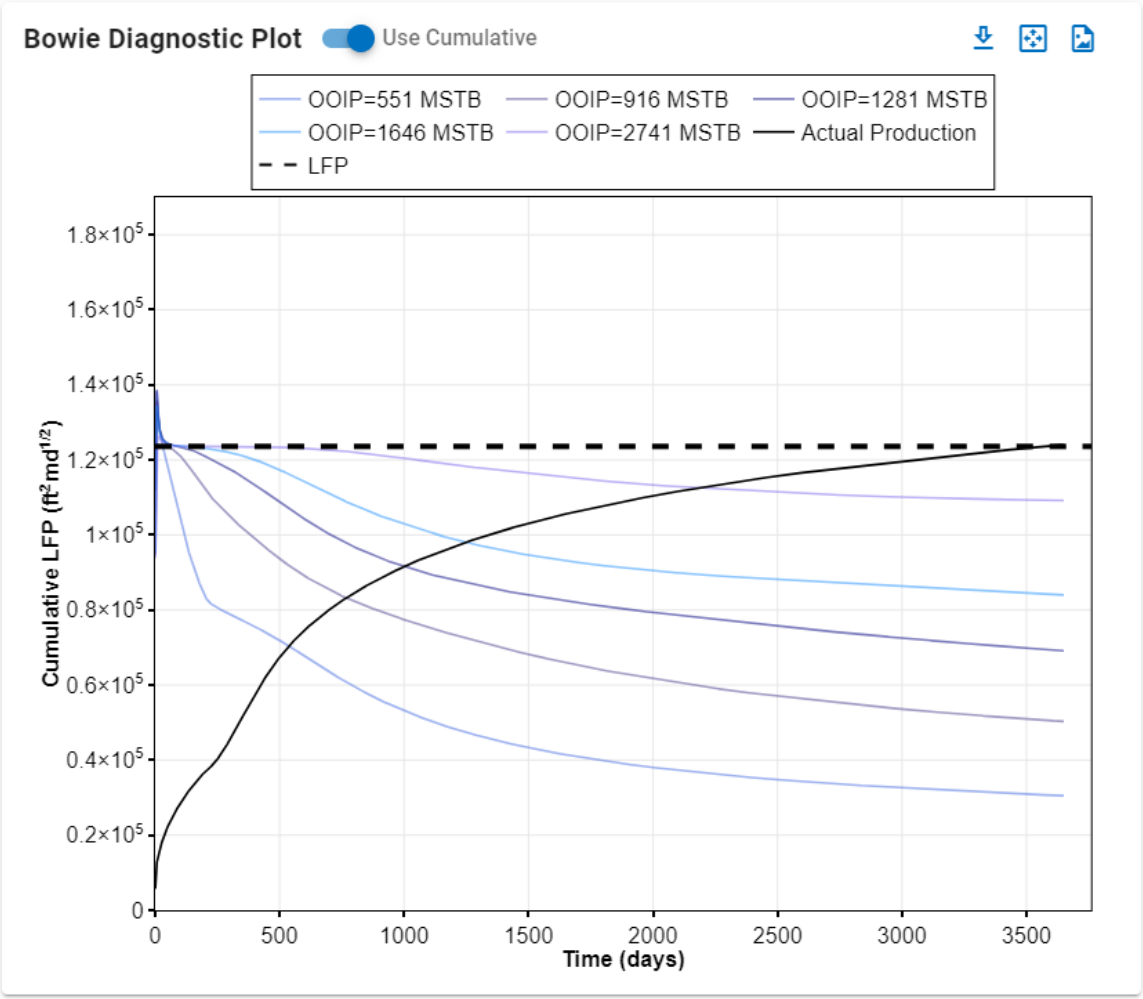






whitson

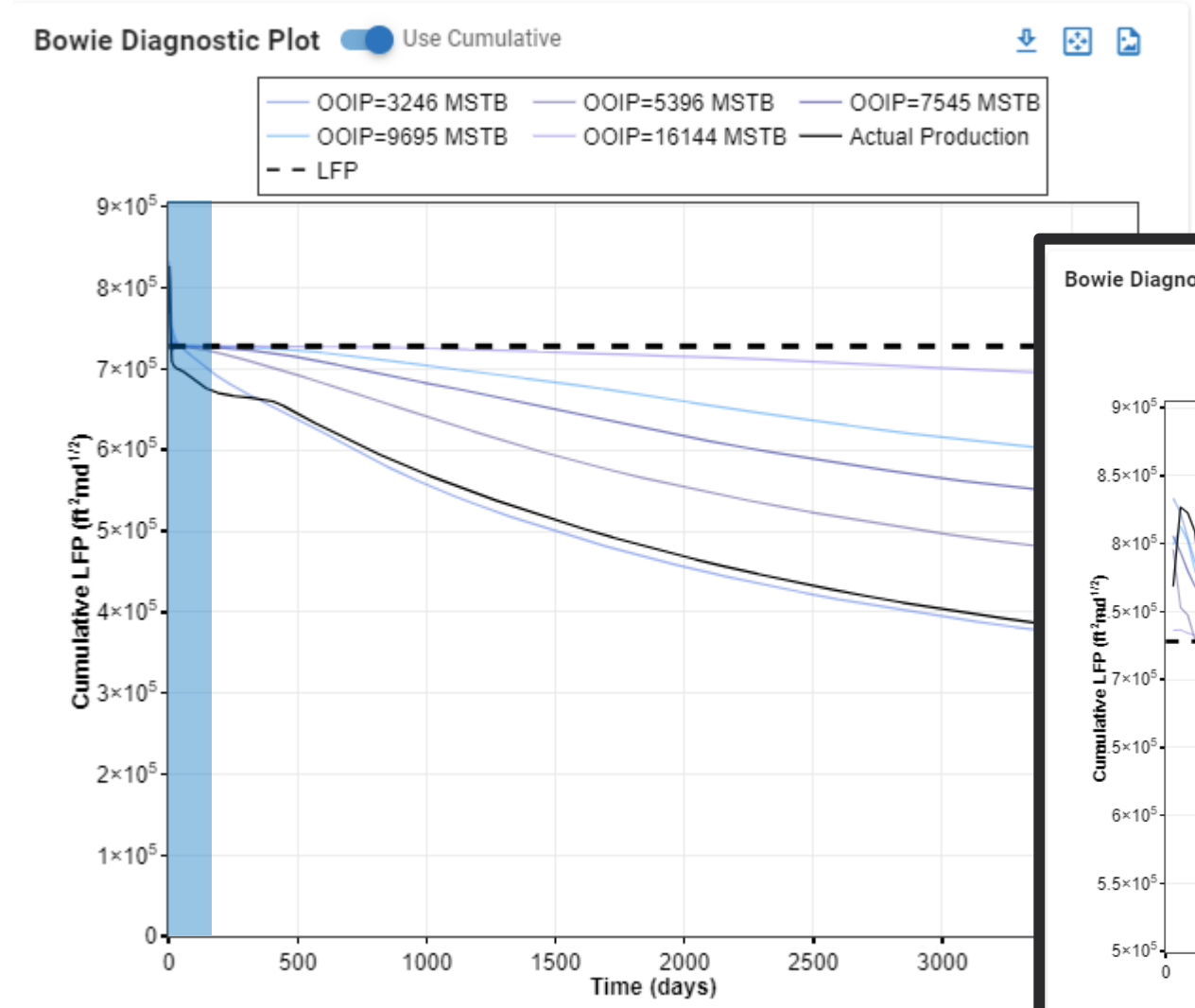
Synthetic Low Fcd Well | Wrong Fcd = 1000



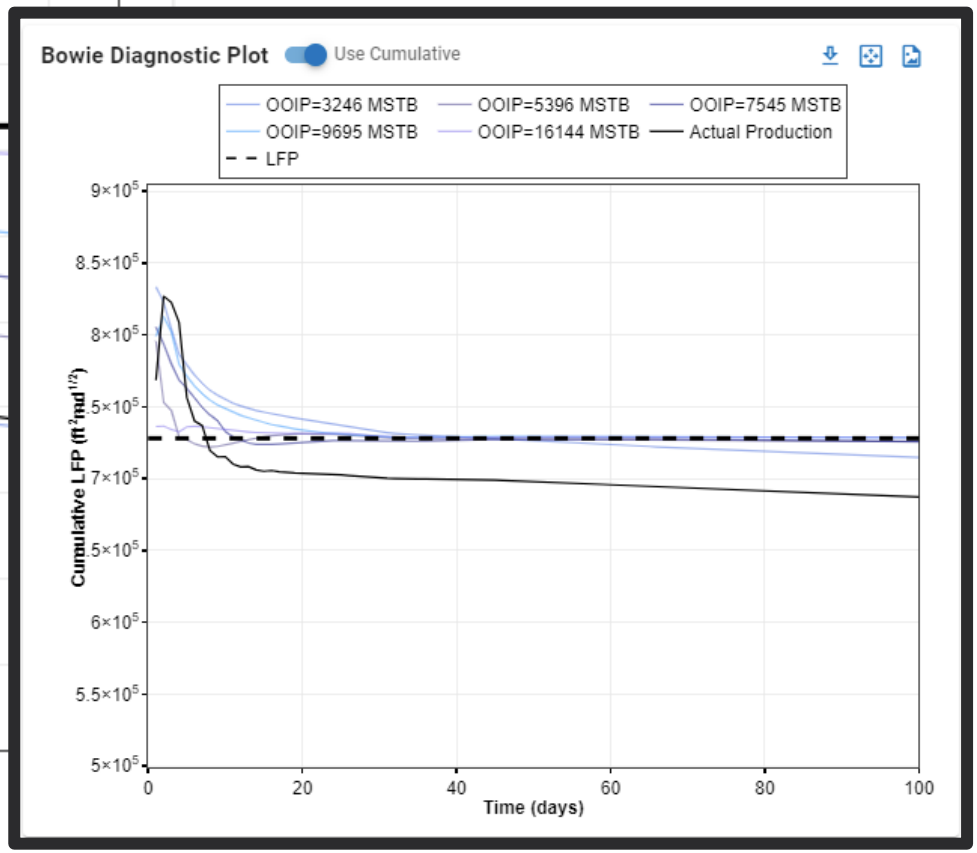
Run NRTA with Fcd = 1000

whitson

Synthetic Low Fcd Well | Wrong Fcd = 1

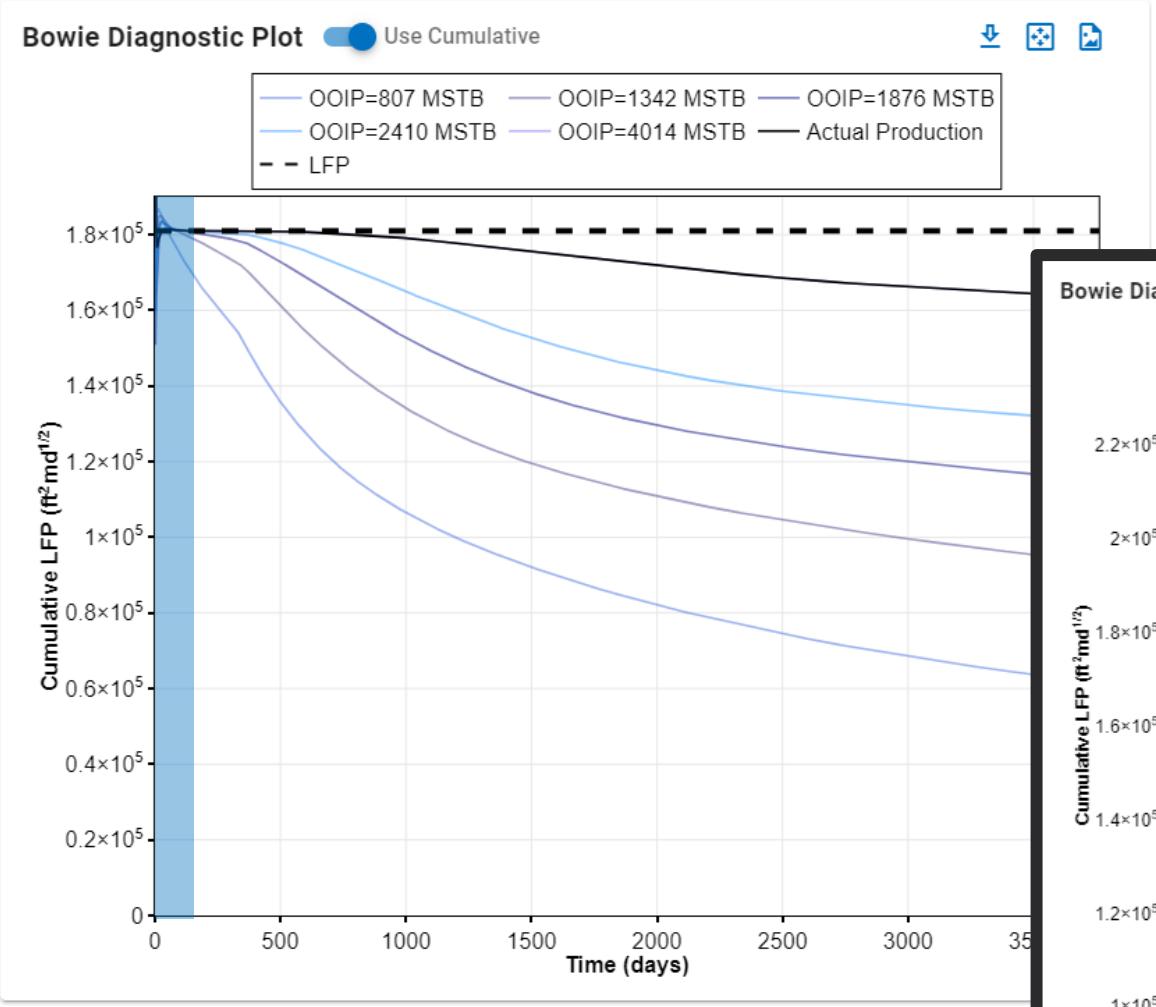


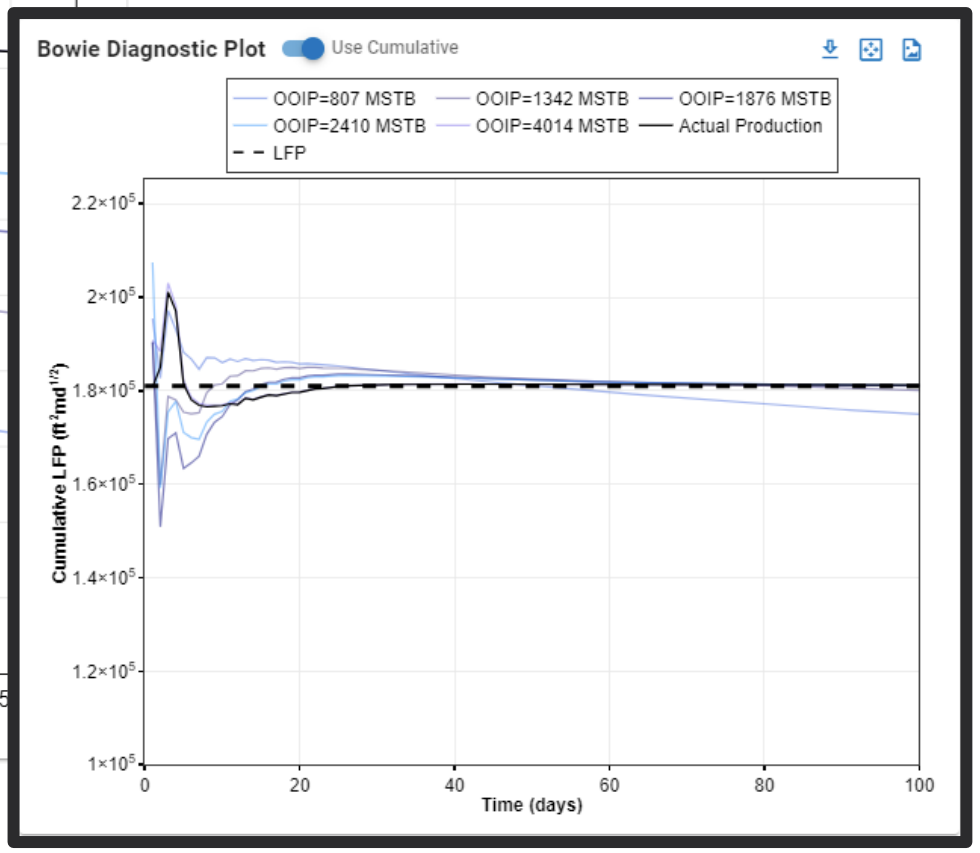
Run NRTA with Fcd = 1



whitson

Low Fcd Well, using Correct Fcd = 5

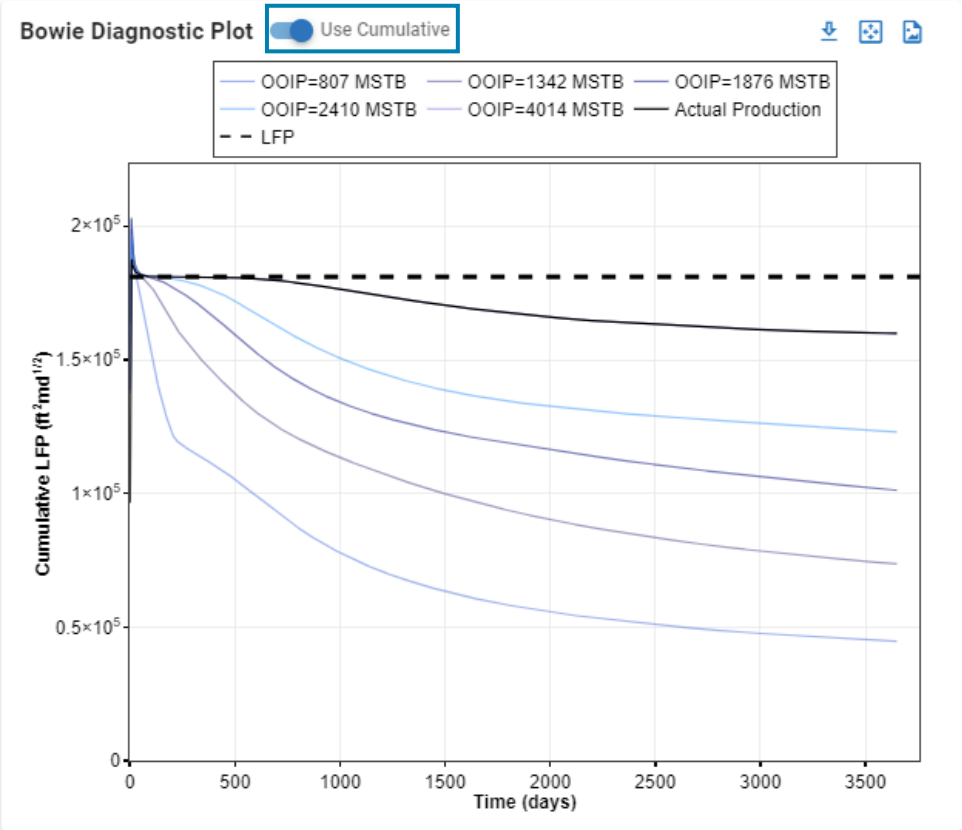


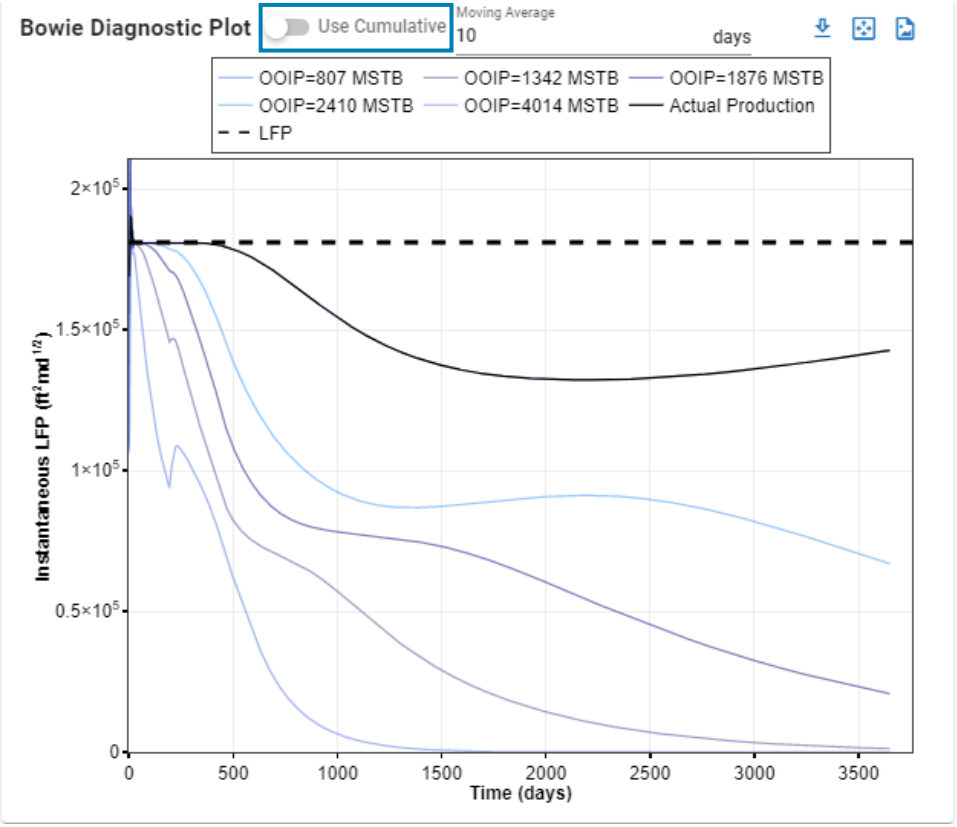


whitson

Cum LFP
vs
Instantenous LFP

Cum LFP vs Instantaneous LFP

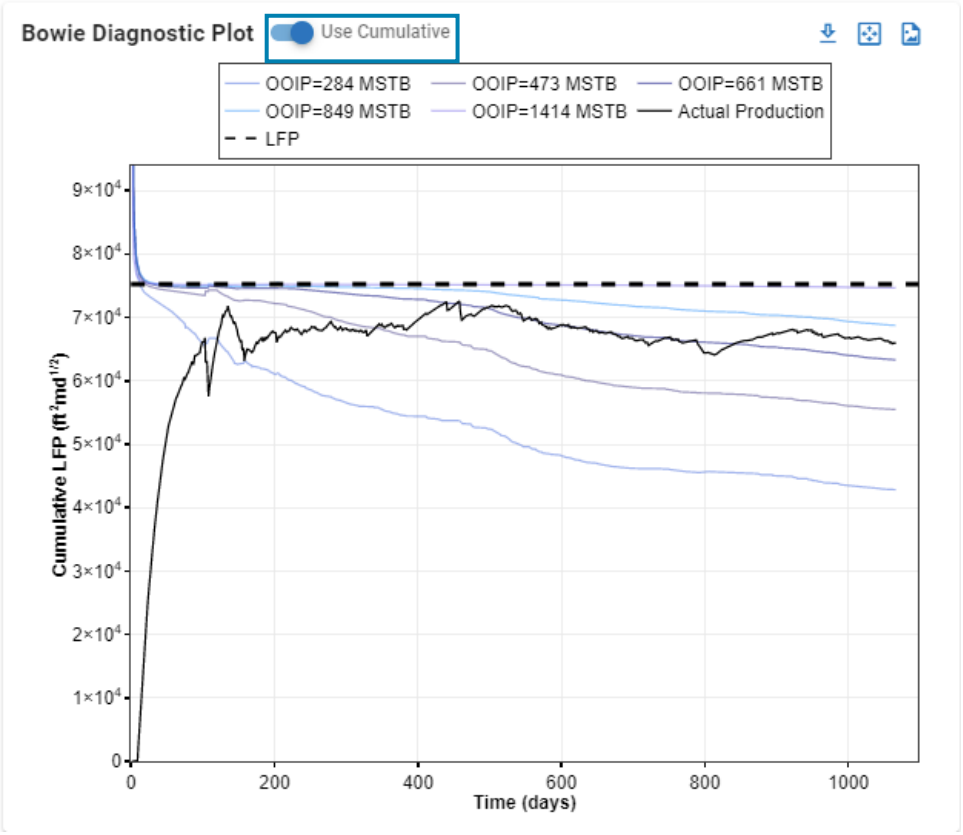


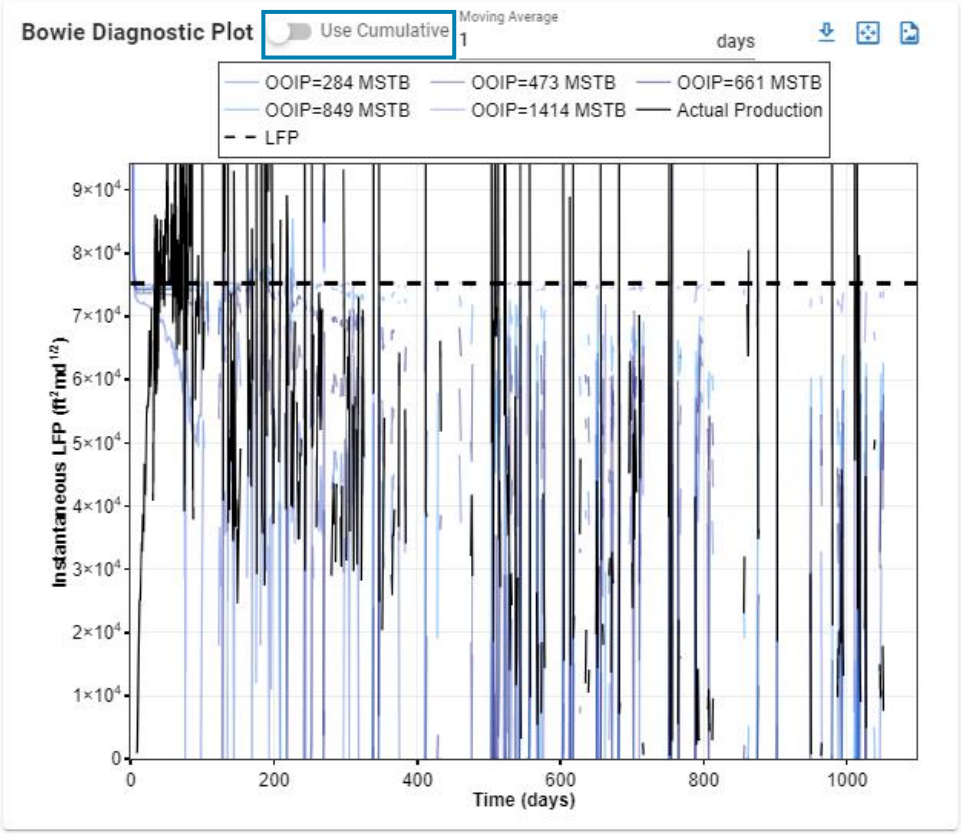


In theory both should show the same results.

whitson

Cum LFP vs Instantaneous LFP



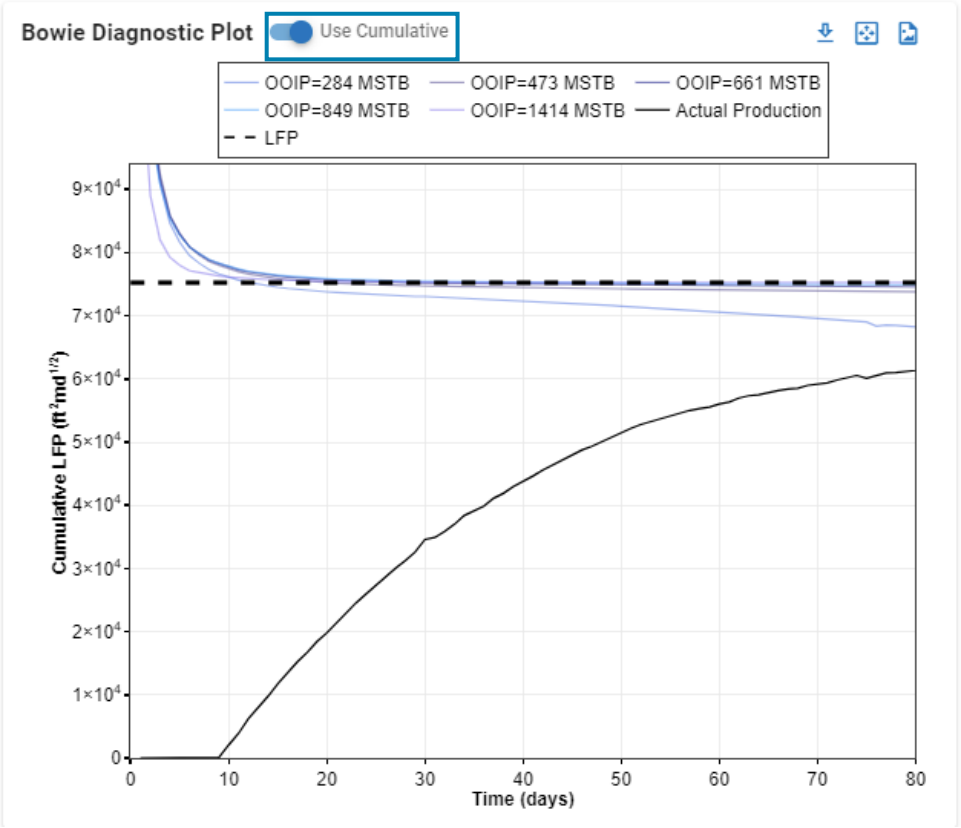


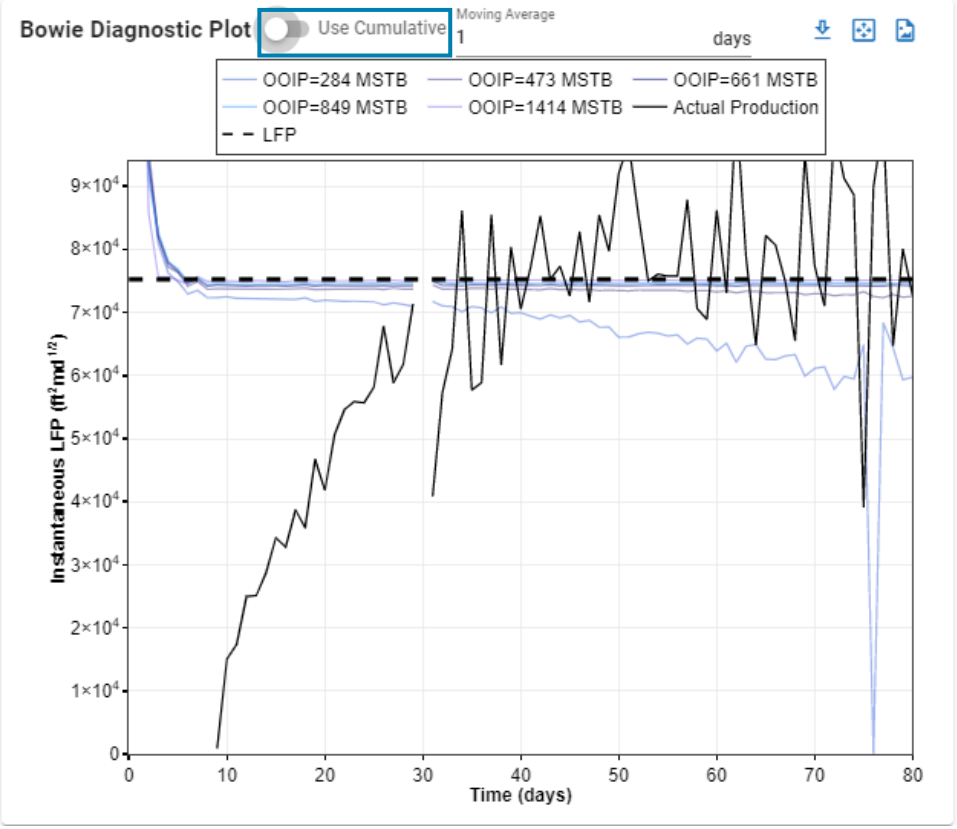
In theory both should show the same results.

In practice, cum LFP helps removing “noise”.

whitson

Cum LFP vs Instantaneous LFP





In theory both should show the same results.

In practice, cum LFP helps removing “noise”.

BUT, cum LFP will be “delayed” due to early-time climbing LFPs

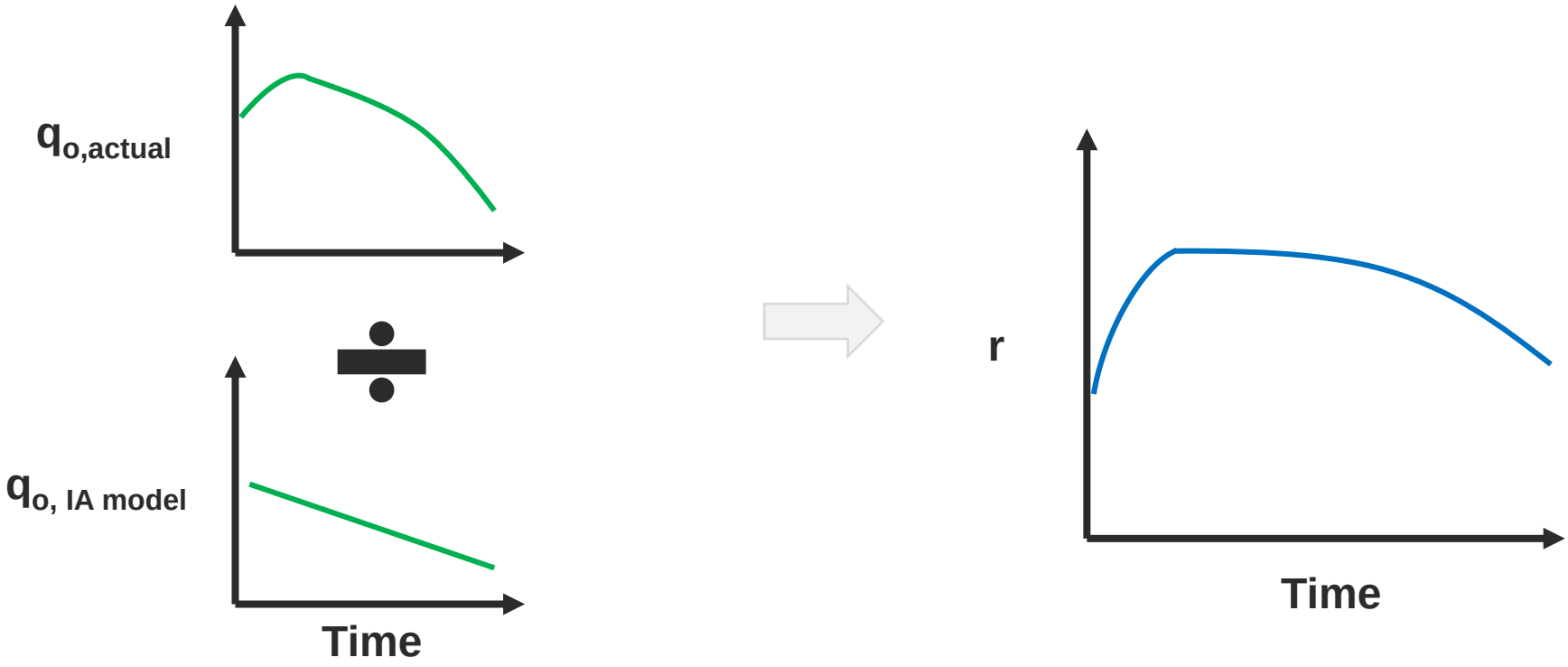
→ **Most important when Cum LFP is still increasing**

whitson

Concluding Remarks

Concluding Remarks

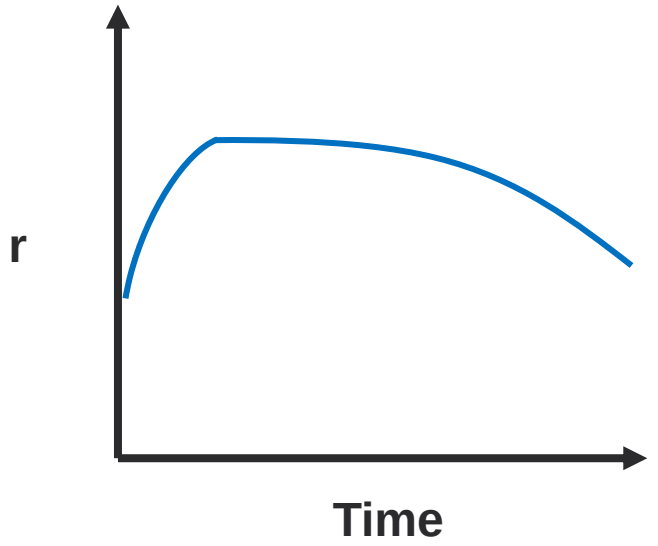
Early “climbing” LFP behavior expected whenever the production from the model is larger than the actual production.



Concluding Remarks

Early “climbing” LFP behavior → q,model > q,actual

1. While the well is producing at decreasing water ratio
2. Fcd, model > Fcd, well
3. p_i, model > p_i, well



And finally:
Cum LFP not always = Instantaneous LFP